Strength& Conditioning (BODYBUILDING)training to win the Marathon

Winning a marathon as a bodybuilding-style strength athlete is about concurrent training: you keep heavy, low-volume lifting to maintain strength and muscle while prioritizing high-volume run work and specific marathon prep.[1][2]

Key principles

- **Primary goal = marathon**
  - Run volume, long runs, and tempo work drive marathon performance; lifting supports durability and efficiency, not the other way around.[3][4]
  - Expect to maintain or slightly lose muscle; aim to keep strength, not push PRs close to the race.[2]
- Manage interference
  - Do strength before cardio if same session, or separate by at least 3–6 hours (ideal 24 hours) to limit strength loss and fatigue.[5][1][2]
  - Cap strength work at 2 sessions per week in peak marathon build for most athletes.[6]

Weekly structure (bodybuilder → marathon)

Assuming 5–6 run days/week, 1 rest day:

- 2 strength days
  - Day A: Heavy lower + core (early week, far from long run).
  - Day B: Power/plyo + unilateral + upper (mid-week).[3][6]
- Key runs
  - 1 long run (progressing to 18–22 miles).

    - 1 tempo / marathon-pace session.
    - 1 interval / VO2 max or hill session.
    - Easy runs fill remaining days for volume and recovery.[4][3]

Example layout (adjust days to your schedule):

- Mon: Strength A + easy run (or AM/PM split).
- Tue: Intervals / hills.
- Wed: Easy run.
- Thu: Strength B + short easy run.
- Fri: Tempo / marathon pace.
- Sat: Easy run.
- Sun: Long run.

Strength session details (bodybuilding-biased)

Focus on compound patterns that transfer to running: squat, hinge, lunge, step-up, calf, core; keep reps lower and sets modest to avoid crippling DOMS.[7][8][3]

Strength Day A – Heavy lower + core

- Back or safety-bar squat: 3–4×3–5 at ~75–85% 1RM (RPE 7–8).[6][3]
- Romanian deadlift: 3×5–6.
- Bulgarian split squat or walking lunge: 3×6–8/leg.[9][7]
- Single-leg calf raise (standing or seated): 3–4×10–15/leg.[3][6]
- Front plank / side plank variations: 3×30–45 s.[6][3]

Strength Day B – Power, unilateral, upper

- Box or squat jumps: 3×3–5 (full recovery between sets).[3][6]
- Single-leg squat, step-up, or split squat: 3×6–8/leg.[7][9]
- Hip hinge: single-leg RDL 3×6–8/leg.
- Push: push-ups or bench 3×8–10.
- Pull: pull-ups/lat pulldown or row 3×8–10.[3]
- Anti-rotation core (cable/band chop, Pallof press): 3×8–12/side.[3]

Keep traditional bodybuilding isolation work minimal and strategic (e.g., some hamstring curls or glute work) to control fatigue.

Programming phases

- Base (16–12 weeks out)
  - Higher lifting volume (3–4×6–10), still low enough not to trash runs.[4][3]
  - Build run frequency and easy mileage.
- Specific prep (12–4 weeks out)
  - Shift to heavier, lower-rep strength (3–5) and fewer total sets; add some plyos.[6][3]
  - Long runs and race-pace work become priority; avoid leg-destroying hypertrophy sessions.
- Taper (last 2–3 weeks)
  - Drop strength to 1–2 short sessions, 2×3–4 on big lifts, lighter or same load; no failure, no heavy eccentrics.[6][3]
  - Maintain a few strides/plyos early in taper, then cut them in race week.

Bodybuilding-specific tips

- Stay ahead of DOMS: avoid high-rep squats/lunges within 3–4 days of long or key pace runs.[4][3]
- Keep total weekly hard sessions to 3–4 (e.g., 2 key runs + 1–2 strength), everything else easy.
- Use your existing **work capacity** to tolerate a bit more plyo and unilateral loading, but let run performance, not pump, be the metric.

If you share your current split (exercises, sets, and run schedule), a fully periodized 12–16 week plan can be built around your show-style bodybuilding work to peak specifically for one marathon.

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Related

How to combine marathon mileage with bodybuilding strength sessions
Best weekly schedule for two strength sessions and four runs
Which compound lifts improve running economy most effectively

Combining marathon mileage with bodybuilding strength work means anchoring the week around your key runs, then inserting two short, heavy, low-volume lifting sessions that emphasize squats, hinges, and unilateral patterns to improve running economy.[11][12][13]

Combining mileage and lifting

- Prioritize key runs
    - Long run, tempo/threshold, and one faster session (intervals/hills) are the non-negotiables; easy runs and strength adapt around these.[14][15][11]
    - Maintain your usual running frequency (4+ days) and adjust lifting volume down to avoid chronic fatigue.[12][13][16]
- Session timing
    - Either lift after easy runs or separate runs and lifting by several hours, avoiding heavy lower-body work before long runs or hard workouts.[15][14][12]
    - Keep strength blocks 30–60 minutes, focusing on 3–5 big movements and skipping to-failure bodybuilding volume for legs in the main marathon block.[17][13][11]

Best weekly schedule (2 lifts, 4 runs)

For a marathon-focused block with two full-body strength sessions and four runs:

- Mon – Strength A (heavy lower emphasis) + optional very easy 20–30 min shakeout.[14][11][15]
- Tue – Quality run: intervals or hills.
- Wed – Easy run.
- Thu – Strength B (power/unilateral/upper) + short easy run if desired.[13][11][12]
- Fri – Tempo or marathon-pace run.

- Sat – Easy run or rest (depending on fatigue).
- Sun – Long run.

Key rules:

- Never place heavy squats/hinges within 24–48 hours before the long run or tempo session.[15][13][14]
- In peak mileage phases, you can drop to 1 short strength session some weeks if recovery tanks.[12][15]

Compound lifts for running economy

Evidence points toward heavy compound lifts (≥ ~80% 1RM, low-to-moderate reps) and plyometrics as the most efficient strength tools to improve running economy.[18][17][13]

- Lower-body strength staples
  - Back/front squat and variations: improve force production, stiffness, and recruitment across glutes, quads, and core.[19][11][13]
  - Deadlift / Romanian deadlift: enhance posterior chain strength for better hip drive and reduced breakdown late in races.[20][18][13]
  - Bulgarian split squat, step-up, and single-leg squat: address asymmetries and build single-leg stability, which closely mimics stance phase in running.[11][20][19]
- Support and performance lifts
  - Calf raises (standing and bent-knee) and hip thrust/glute bridge for ankle stiffness and hip extension power.[20][19][11]
  - Plyometrics (box jumps, split jumps, bounds) layered on top of strength for additional improvements in running economy, especially at submaximal speeds.[18][17][11]

Example bodybuilding-flavored strength sessions

Strength A – Heavy lower + core (Mon)

- Back or front squat: 3–4×3–5 at ~80–85% 1RM (RPE 7–8).[13][18][11]
- Romanian deadlift: 3×5–6.
- Bulgarian split squat: 3×6–8/leg.

- Standing calf raise: 3×8–12.
- Plank or anti-rotation core: 3×30–45 s.[19][11]

Strength B – Power / unilateral / upper (Thu)

- Box or squat jumps: 3×3–5 (full recovery).[18][11]
- Step-ups or single-leg squats: 3×6–8/leg.
- Hip thrust or glute bridge: 3×6–8.
- Bench or weighted push-ups + row or pull-ups: 3×8–10 each.[11][20]
- Optional calves or light accessories if recovery allows.[20][13]

If you drop your current split (days, movements, sets, and where you want the marathon in your season), a custom week-by-week layout can be built so you keep as much bodybuilding strength/size as possible while peaking for a race.

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Related

How to periodize strength training across a marathon training cycle
Sample 12 week plan combining 4 runs and 2 heavy lifting days
Which lifts to prioritize during peak marathon mileage weeks

Strength work across a marathon cycle should move from slightly higher-volume general strength to low-volume heavy/plyometric work, then taper to minimal maintenance during peak mileage and race weeks.[21][22][23]

Periodizing strength in 3 phases

1. Weeks 1–4: General prep / base

- Goals: Build basic strength, tendon tolerance, and lifting skill while mileage ramps gradually.[24][22][23]
- Lifting style:
  - 2×/week, 30–45 min.
  - Main sets mostly 3×6–10, RPE 6–7.

- Focus on big patterns: squat, hinge, lunge, push, pull, calf, core.[25][23][21]

2. Weeks 5–9: Specific / heavy phase

- Goals: Maximize useful strength and stiffness for running economy while marathon workouts and long runs peak.[26][21][24]
- Lifting style:
  - Still 2×/week, 30–40 min.
  - Shift to heavier loads, 3–5 reps, RPE 7–8, fewer total sets.
  - Add low-volume plyometrics (jumps, hops) after warm-up or early in session.[27][21][25]

3. Weeks 10–12: Peak mileage + taper

- Goals: Maintain strength, reduce fatigue, sharpen for race day.[22][24][26]
- Lifting style:
  - Weeks 10–11: 1–2 short sessions, 2×3–4 on key lifts, submax loads, no failure.[28][23][21]
  - Week 12 (race week): 0–1 very light session early in the week, or skip entirely if you feel beat-up.[21][24][28]

Sample 12-week (4 runs + 2 heavy lifts)

Assume:

- Runs: long, tempo/MP, one quality (intervals/hills), one easy.
- Lifts: full-body with lower emphasis, “bodybuilding-style” but low volume.

Weekly layout

- Mon – Strength A
- Tue – Quality run (intervals/hills)
- Wed – Easy run
- Thu – Strength B + short easy jog (optional)
- Fri – Tempo / marathon-pace run
- Sat – Rest or very easy run

- Sun – Long run[24][26][21]

Strength A (heavier, more bilateral)

- Back or front squat
- Romanian deadlift
- Bulgarian split squat or step-up
- Standing or seated calf raises
- Core (plank / anti-rotation)[23][25][21]

Rep schemes by phase:

- Weeks 1–4: 3×6–8 each (moderate load).
- Weeks 5–9: 3–4×3–5 on squat and RDL, 2–3×5–6 on accessories.
- Weeks 10–11: 2×3–4 on squat and 1–2×5 on others; week 12 cut or go 2×3 very light early in week.[27][23][21]

Strength B (power/unilateral/upper)

- Plyo: box jumps or squat jumps 3×3–5.
- Single-leg squat or lunge / split squat.
- Hip thrust or glute bridge.
- Push (bench / push-ups) + pull (row / pull-ups).
- Optional calves or light accessories.[25][21][27]

Rep schemes by phase:

- Weeks 1–4: 3×6–10 on strength lifts, low-intensity plyos.
- Weeks 5–9: 3×3–5 on lower, 2–3×5–8 upper, plyos stay 3×3–5.
- Weeks 10–11: Mostly 2×3–5 or even 2×3; skip extra accessories.[28][21][25]

Lifts to prioritize in peak mileage

During the heaviest run weeks, keep only the most **transferable** movements and trim everything else.

- Core lower-body staples

    - Back or front squat (or safety bar squat) for global lower-body strength and stiffness.[21][25]
    - Romanian deadlift or conventional deadlift for posterior chain and late-race durability.[25][28]
    - Bulgarian split squats / step-ups for single-leg control and hip stability.[21][25]
- Key support moves
    - Calf raises (straight- and bent-knee) to support ankle stiffness and protect Achilles.[25][21]
    - Simple upper-body push/pull (push-ups/bench, rows/pull-ups) for posture and arm swing, done light-moderate so they never interfere with running.[23][25]
- What to reduce or park
    - High-rep leg hypertrophy work (leg press marathons, drop-set lunges).
    - Fatigue-heavy isolation for quads/hams/glutes; keep it minimal or cluster it away from key run days in early weeks only.[28][21]

If you want, share your target marathon date, recent 1RM ranges for squat/bench/deadlift, and typical running mileage; from there a week-by-week 12-week table can be laid out with exact sets, reps, and progression.

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How should intensity change across base build build and peak phases

How to adjust strength volume during high mileage weeks
Week by week example for 12 week peak phase with 4 runs 2 lifts per week

Intensity should rise from moderate in base, to heavier but still controlled in build, then ease back in peak while you maintain key lifts and let the run work do the sharpening.[31][32]

Intensity across phases

- **Base (weeks 1–4 of a 12-week peak block)**
    - Strength: moderate loads, roughly 65–75% 1RM, sets of 6–10, RPE 6–7; focus on movement quality and tolerating concurrent mileage.[33][31]
    - Running: mostly easy mileage with a modest long run and light strides; one controlled tempo or progression run at most.[34][35]
- **Build (weeks 5–8)**
    - Strength: shift heavier to about 75–85% 1RM, sets of 3–6, RPE 7–8, but slightly *less* total volume than base; small amount of plyo.[36][37][31]
    - Running: long runs extend, marathon-pace and threshold work become central, plus one faster or hill session.[38][39]
- **Peak (weeks 9–12 before race, including taper inside this window)**
    - Strength: drop to maintenance—1–2 sessions, 2×3–4 on the big lifts at ~70–80% 1RM, no grinders, no DOMS-inducing work.[36][31]
    - Running: longest long runs and most race-specific intensity, then 2-week taper where volume drops but some pace work stays.[32][40]

Adjusting strength volume in high mileage weeks

- Cut **sets**, not all intensity
    - Keep heavy work but limit to 2–3 total working sets per major pattern (squat/hinge/unilateral), instead of 4–5+.[31][36]
    - Avoid extra hypertrophy accessories for legs; keep any isolation light and optional.
- Protect key run days
    - No heavy lower session within 24–48 hours before your longest run or big marathon-pace workout.[35][40]
    - Place strength on days with easy or shorter runs, and shorten the session to 30–40 minutes.

Week-by-week 12-week peak example

Assumptions:

- 4 runs: long, tempo/MP, one quality (intervals/hills), one easy.
- 2 lifts: full-body with lower emphasis.
- Race at end of Week 12 (taper in Weeks 11–12).

Weekly template (fixed)

- Mon – Lift A (heavy bias)
- Tue – Quality run (intervals/hills)
- Wed – Easy run
- Thu – Lift B (unilateral + power + upper)
- Fri – Tempo / marathon-pace run
- Sat – Rest or very easy
- Sun – Long run[34][35]

Strength structure by week

- **Weeks 1–4 (base inside peak block)**
  - Lift A: Squat 3×6–8; RDL 3×6–8; split squat 2–3×8; calves and core 2–3×10–12.
  - Lift B: Light jumps 3×3–5; step-up 3×6–8; hip thrust 3×6–8; bench + row 3×8–10; optional calves.[36][31]
  - Aim for ~6–9 total hard sets for legs per session.
- **Weeks 5–8 (true build / heavy)**
  - Lift A: Squat 3–4×3–5 at 75–85%; RDL 3×4–6; split squat 2×5–6; calves 2–3×8–10; brief core.[37][31]
  - Lift B: Jumps 3×3–5; single-leg squat or lunge 3×5–6; hip thrust 2–3×5–6; bench + row 2–3×6–8.
  - Leg sets drop slightly (5–7 hard sets), but average load and intent go up.
- **Week 9–10 (early peak, high mileage)**
  - Lift A: Squat 2–3×3–4 at ~75–80%; RDL 2×4–5; single-leg 1–2×5/leg; 1–2 light calf/core sets.

    - Lift B: Jumps 2–3×3; one unilateral pattern 2×5; hip thrust 2×4–6; one upper push + pull 2×6–8.
    - Total leg volume lowest so far, intensity still solid but everything submax and crisp.[31][36]
- **Week 11 (taper begins)**
    - One or two **very short** sessions:
        - Example A: Squat 2×3 at ~70–75%; RDL 2×3–4; light core.
        - Example B (optional): 2×3 jumps, 2×5 split squat, couple of upper-body sets.
    - Goal is to feel snappy, not tired.
- **Week 12 (race week)**
    - Optional single micro-session 5–6 days out: 2×3 light squats + a few jumps + brief core, all well below fatigue.[40][32]
    - Otherwise skip lifting; focus on short, pace-touching runs and freshness.

Lifts to emphasize in peak weeks

During the highest mileage (roughly Weeks 7–10 here), prioritize:

- One bilateral squat pattern (back/front/safety bar) and one hinge (RDL or conventional).[37][31]
- One unilateral lower-body pattern (Bulgarian, step-up, or single-leg squat) at low volume.
- Calf raises and a simple core pattern; minimal but consistent.[36]

If you want, the next step can be writing this out as a table with exact set/rep prescriptions you can drop straight into a spreadsheet.

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How to taper strength sessions in the final 2 weeks before race day

Specific rep and load targets for base build and peak phases
How to reduce lifting volume during three consecutive high mileage weeks

Taper strength in the last 2 weeks by sharply cutting volume (sets and exercises), slightly easing load, and keeping only a few crisp, familiar lifts far from race day.[41][42][43]

Strength taper: final 2 weeks

- 2 weeks out
  - Keep 1–2 short sessions, 20–30 minutes each.[44][41]
  - Use ~60–75% of your recent working loads, stopping 3–4 reps shy of failure, with 2×3–5 on big lifts and minimal accessories.[42][43]
- Race week (final 5–7 days)
  - Either one micro-session 4–5 days out (2×3 light squats/hinge + a bit of core), or no lifting at all if you're fatigue-sensitive.[45][42]
  - Avoid any new movements, high-rep "pump" work, or heavy eccentrics; focus only on feeling snappy and fresh.[46][47]

Rep/load targets by phase

Use RPE as your anchor, given your bodybuilding background.

- Base phase (general prep inside marathon build)
  - Main lifts: 3×6–10 at ~65–75% 1RM, RPE 6–7.[48][49]
  - Accessories: 2–3×8–12, but keep leg isolation modest so it doesn't wreck run quality.
- Build phase (heavier, more specific)
  - Main lifts: 3–4×3–6 at ~75–85% 1RM, RPE 7–8, with 1–2 compound lower patterns per day (squat + hinge / unilateral).[49][48]
  - Accessories: 1–2×6–10 each, only what supports running (calves, core, some upper).
- Peak / high-mileage + taper start
  - Main lifts: 2–3×3–4 at ~70–80% 1RM, RPE 6–7, fast concentric.[43][44]

    - Accessories: either 1 light set or dropped entirely for legs; keep just a couple of upper-body/core sets.

Reducing volume in three high-mileage weeks

For a 3-week high-mileage block, think “keep intensity, cut work.”

- Week 1 high mileage
    - Keep 2 sessions but:
        - Reduce lower-body working sets by ~30–40% (e.g., from 4 sets to 2–3).[47][43]
        - Keep load similar (70–80% 1RM, RPE ~7) and cut some accessories.
- Week 2 high mileage
    - Maintain 2 sessions, but:
        - One becomes very light/short (mostly upper/core, only 1–2 lower-body sets).
        - Total weekly hard sets for legs ≈ 6–8 across both days, all submaximal.[43][44]
- Week 3 high mileage (or final hard week before taper)
    - Drop to 1 meaningful strength session plus optional brief activation work.
    - Use 2×3–4 on one squat pattern and 2×3–4 on one hinge or unilateral; maybe a couple of calf/core sets, then out.[42][45]

If you share your usual 1RMs and approximate marathon-phase mileage (e.g., 40 vs 70+ mpw), the exact set/rep prescriptions for each of those three weeks can be tuned tightly to your recovery capacity.

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Best strength exercises to maintain running economy during taper

Exact rep and load ranges for 7 to 14 day taper
How to structure 2 weekly strength sessions during final two weeks

The best taper strength work keeps your running-specific muscles “online” with very low volume, familiar movements, and moderate loads that never create soreness or fatigue going into race day.[53][54]

Best exercises for running economy in taper

Focus on the same big patterns you’ve used all cycle, but trimmed down:

- Squat pattern: back/front/safety-bar squat or goblet squat (partial or to a box to reduce soreness).[54][53]
- Hinge pattern: Romanian deadlift or hip hinge, light-moderate range.[55][54]
- Unilateral: split squat, step-up, or single-leg squat, low volume for stability.[56][53]
- Calf work: single-leg calf raises (straight- and bent-knee) to maintain ankle stiffness.[53][55]
- Light power: a few squat/box jumps or bounds to keep neuromuscular snap, if you’ve already used them in training.[55][53]

Exact rep and load ranges (7–14 day taper)

Use these as a guideline, assuming you’ve been lifting heavier earlier in the block:

- 14–8 days before race
    - Intensity: ~70–80% of recent working weights (roughly RPE 6–7).
    - Main lifts: 2–3 sets of 3–5 reps for 1 squat and 1 hinge or unilateral lift per session.[54][53]
    - Accessories: at most 1–2×6–8 for calves and 1–2 short core sets; upper-body 1–2×6–8 if you want to “grease the groove.”[57][53]
- 7–4 days before race
    - Intensity: ~60–70% of recent working weights (RPE 5–6), focus on speed of concentric.
    - Main lifts: 1–2 sets of 3–4 reps on 1–2 key moves only (e.g., squat + calf raises).[53][54]

    - No new exercises, no high-rep sets, no tempo work, no failure.
- Final 3 days
    - No lifting, or at most a 5–10 minute activation (bodyweight lunges/bridges, band work) if you feel better with it.[58][56]

Structuring 2 sessions in the final 2 weeks

Assume race is on Sunday.

14–8 days out (Week −2)

- **Session 1: Mon/Tue**
    - Squat (barbell or goblet to box): 2–3×4–5 @ ~70–80% of prior working load.
    - RDL or hip hinge: 2×4–5.
    - Single-leg calf raises: 2×6–8/leg.
    - Short core (plank or anti-rotation): 2×20–30 s.[54][53]
- **Session 2: Thu**
    - Squat or split squat: 2×3–4 (same load feel, slightly fewer reps).
    - Step-ups or single-leg squat: 2×4–5/leg.
    - Calves: 2×6–8/leg.
    - 1–2 easy sets each of push/pull for posture (e.g., push-ups + rows).[56][53]

7–1 days out (Race week)

- **Single micro-session: Mon or Tue**
    - Squat (to box or partial): 2×3 @ ~60–70% of working load, fast but relaxed.
    - Calf raises: 2×6–8/leg, easy.
    - Optional: 1–2×3 small jumps or bounds if you've done them all cycle, or skip if you're twitchy with fatigue.[53][54]
    - Total time: 15–20 minutes; stop while you still feel fresh.
- **Wed–Sat**

    - No heavy strength; only light mobility and bodyweight activation if desired.[58] [56]

If you share your usual working weights on squat/RDL and where your long run is placed in race-week, the rep/load targets can be dialed in to exact kilo increments and placed precisely relative to your last long run and your marathon.

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Which compound lifts best preserve power during a taper

How to schedule two strength sessions with race day 3 days away
Sample 7 day taper strength session with sets reps and loads per lift

For preserving power in a taper, keep a very small menu of heavy-ish compound lifts—mainly squat, hip hinge, unilateral, and calf work—done with low volume and submax effort so you stay snappy without adding fatigue.[63][64]

Best compound lifts to preserve power

- Squat pattern
    - Back squat, front squat, or safety-bar/goblet squat maintain quad–glute strength and stiffness that drive late-race force production and shock absorption.[65][63]
    - Use the variation you've already trained all cycle to avoid new-exercise soreness.
- Hinge + hip extension
    - Romanian deadlift, trap-bar deadlift, or hip thrust maintain posterior chain power and improve recruitment at toe-off.[63][65]
    - These are highly efficient for maintaining running economy with very few sets.
- Unilateral + calf

    - Split squat or step-up for single-leg stability and force in a run-specific stance.[66][67]
    - Standing and bent-knee calf raises to preserve ankle stiffness and elastic recoil, crucial for economy.[67][68]

Rep and load ranges with race 7–3 days away

Across this period, taper volume, not intensity: keep loads moderate, sets very low, and never go near failure.[64][69]

- 7–5 days out
    - Load: about 70–80% of the loads you used in your last full strength block (roughly RPE 6–7).
    - Main compounds (squat + hinge or unilateral): 2×3–5 reps each; stop well short of grinding.[67][64]
    - Calf + core: 1–2×6–8 reps or 20–30 s holds.
- 4–3 days out (last strength exposure if you tolerate it well)
    - Load: about 60–70% of prior working loads (RPE 5–6), focus on fast but controlled concentric.
    - Main compound: 1–2×3–4 reps on 1–2 key lifts only (e.g., goblet squat + calf raises).[69][64]
    - No plyos if you're at all beat-up; small number of familiar low-amplitude jumps only if they've been present all cycle.

Scheduling two strength sessions when race day is 3 days away

Assume race is Sunday. With race day 3 days away (Thursday), both strength sessions must fall early in the week and be short.

- 7 days out (Sunday prior)
    - Long run finishes this day; no lifting.
- **Session 1: Monday (−6 days)**
    - Primary "maintenance" day, slightly higher load and volume:

        - Squat variation: 2×4–5 @ ~70–80% recent working weight.[64][67]
        - RDL or hip thrust: 2×4–5.
        - Single-leg calf raise: 2×6–8/leg.
        - Short core: 2×20–30 s plank or anti-rotation.
- **Session 2: Wednesday (−4 days)**
    - Lighter “activation” day:
        - Goblet squat or front squat: 1–2×3–4 @ ~60–70% working load.
        - Split squat or step-up: 1–2×3–4/leg, same load feel.
        - Calf raises: 1–2×6–8/leg.
        - Optional: 1–2×6–8 easy rows or push-ups for posture.[65][69]
- Thursday (−3), Friday (−2), Saturday (−1)
    - No strength; only easy runs, strides, and mobility as your run plan dictates.[70][71]

Sample 7-day taper strength prescription

Again assuming race Sunday and typical submax bodybuilding-level strength.

Day-by-day outline

- **Mon (−6): Strength Session 1 – Maintenance**
    - Back or safety-bar squat
        - 2 sets × 4–5 reps @ ~70–80% of your last build-phase working weight (so if you worked with 365 lb, use ~255–295 lb).
    - Romanian deadlift
        - 2×4–5 @ ~70–75% of your usual working weight.
    - Bulgarian split squat
        - 2×4–5/leg with a load you’d normally use for 6–8 reps.
    - Standing calf raise
        - 2×6–8/leg, moderate but smooth.

    - Core: plank or cable anti-rotation
        - 2×20–30 s, not to failure.[63][67]
- **Tue (−5): Easy run + mobility**
    - No lifting.
- **Wed (−4): Strength Session 2 – Activation**
    - Goblet or front squat
        - 1–2×3–4 @ ~60–70% of recent working load (light enough you could easily do 6+).
    - Step-up or split squat
        - 1–2×3–4/leg with a load you could usually do for 6–8.
    - Single-leg calf raises
        - 1–2×6–8/leg, smooth tempo.
    - Optional: 1×6–8 each of push-ups and rows to keep upper-body patterning.[69][65]
- **Thu (−3): Short easy run or off**
    - No strength; maybe light band hip/glute activation if you like.
- **Fri (−2): Easy run with a few strides**
    - No strength.[71][70]
- **Sat (−1): Shakeout jog or rest**
    - No strength, just light mobility.
- **Sun (0): Race day**

This keeps your key compound lifts in rotation, trims total work dramatically, and schedules both sessions far enough from race day to preserve power and freshness without risking DOMS or central fatigue.[72][64]

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Which accessory exercises support compound lift power retention

How to adjust load and intensity three days before race day
Detailed warm up and activation routine before tapered lifts

Accessory work in the taper should be minimal, specific, and chosen to keep weak links online without creating fatigue. Three days before the race, loads and intensity drop, and your warm-up becomes the main “work.”[76][77]

Accessory exercises that support power

Use just a few **low-fatigue** accessories that directly reinforce your key patterns:

- For squat / unilateral patterns
  - Reverse lunge or split squat, 1–2×6–8/leg, moderate load.
  - Light leg extension or band TKE only if you know they never cause DOMS.
- For hinge / hip extension
  - Single-leg hip thrust or glute bridge, 1–2×8–10.
  - Nordic hamstring (assisted) 1×3–5 if you’ve used it all cycle and tolerate it.
- For ankle and trunk
  - Single-leg calf raises, 1–2×8–10/leg, smooth tempo.
  - Side plank or anti-rotation press, 1–2×20–30 s.

Skip anything that’s “bodybuilding hard” (drop sets, slow eccentrics, big pump work) in the final 10–14 days.

Adjusting load and intensity 3 days out

Three days before the race, think “light activation”:

- Load
  - ~50–60% of your normal working weight on the big lift for that phase, or a weight you could easily do for 8–10 reps while performing only 3–4.[77]
- Volume

    - 1–2 sets of 3–4 reps on 1–2 compound moves (e.g., goblet squat + calf raises).
- Effort
    - RPE around 4–5: every rep moves fast, with 4–6 reps in reserve.
- Goal
    - Central nervous system “ping,” no local fatigue or lingering tightness the next day.

If you’re the type who holds onto fatigue, you can skip lower-body loading entirely three days out and just use bodyweight activation.

Warm-up and activation before tapered lifts

Keep this tight and progressive; total time 10–15 minutes.

1. **General warm-up (3–5 minutes)**
    - Easy jog, bike, or brisk walk.
    - Add arm swings and marching to bring HR up slightly.
2. **Dynamic mobility (3–5 minutes)**
    - Leg swings front–back and side–side, 10–15/leg.
    - Walking lunges with reach, 6–8 steps/leg.
    - Deep bodyweight squat sit for 20–30 s with gentle prying.
    - Hip airplanes or single-leg RDL reach, 5–6/side.
3. **Running-specific activation (3–5 minutes)**
    - A-march / A-skips in place or short 10–15 m strips, 2–3 passes.
    - Heel raises: 15 slow bodyweight, then 8–10 faster reps.
    - Light band work (optional):
        - Lateral band walks, 2×8–10/side.
        - Mini-band glute bridge, 1×10–12.
4. **Lift-specific ramp-up sets**
    - Squat pattern:
        - Empty bar or very light goblet, 2×5.

        - Then 1×3 at ~40–50% of your taper load.
    - Hinge pattern (if used):
        - Hip hinge with just the bar or light DBs, 1–2×5.
    - Only after that do the 1–2 working sets (e.g., 2×3–4) you planned.

This keeps your system primed for power, lets you move crisply under submax weights, and avoids any surprise stiffness as you head into race-week key runs.

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Best accessory exercises to maintain squat power during taper

How to reduce intensity for deadlift three days before race day
Activation sequence to prime nervous system before tapered lifts

Accessory work in the taper should be minimal and specific: choose a few low-fatigue movements that keep the pieces of your squat and pull online, while dropping both intensity and volume three days before the race. (Note: live citation tools are unavailable this turn, so specific external references cannot be provided.)

Accessory work to maintain squat power

Emphasize accessories that:

- Match squat joint angles and force vectors
- Are familiar (no new movements)
- Have low DOMS risk at low volume

Good choices (pick 2–3 total):

- Front squat (light): great as a “bridge” from heavy back squat to taper work; 1–2×3–4, very submax.
- Bulgarian split squat or step-up: keeps unilateral quad–glute strength and hip stability; 1–2×4–6/leg.

- Reverse lunge (in place or walking): slightly more hip-dominant; 1–2×6/leg.
- Reverse hyper / 45-degree back extension: maintains posterior chain and spinal erectors with low joint stress; 1–2×10–12, easy.
- Light paused squat (bodyweight or goblet): 2–3 s pause in the hole for position and stiffness; 1–2×3–4.

During the last 10–14 days, treat these as **technique and tone**, not hypertrophy: fewer sets, normal or slightly reduced load, no grinding.

Reducing deadlift intensity three days before race

Three days out, anything hip-hinge related is “reminder, not stimulus.”

Guidelines:

- Drop the movement from true deadlift → RDL or block pull, or skip the pattern entirely if your back is sensitive.
- Use about **50–60%** of your recent working weight, or a load you could comfortably do for 8–10 reps, but perform only 3–4 reps.
- Limit to **1–2 sets** of 3–4 crisp, fast reps—bar speed is the priority.
- Keep RPE around **4–5**: many reps still in reserve, no bracing strain, no tightness afterward.
- If your long run or last marathon-pace session was very taxing, it is perfectly acceptable to do **no deadlift/hinge at all** three days out and rely only on lighter glute bridges or activation drills.

In other words: either a tiny RDL “touch” (1–2×3–4 @ ~50–60%) or nothing.

Activation sequence before tapered lifts (CNS-focused)

Use this 10–15 minute sequence to get you neurologically “on” with minimal fatigue.

1. General raise (3–4 minutes)

- Easy bike, jog, or brisk walk.
- Add arm circles, shoulder rolls, gentle trunk rotations.

2. Dynamic mobility (3–4 minutes)

- Leg swings front–back and side-to-side, 10–15/leg.
- Walking lunges with reach, 6–8 steps/leg.
- Deep bodyweight squat hold for 20–30 s, prying hips gently.
- 5–6 hip airplanes or single-leg RDL reaches per side.

3. Running/squat activation (3–5 minutes)

- A-march / A-skip for 2–3 short passes (10–15 m or in place).
- Bodyweight or goblet squats, 2×5.
- 15 slow calf raises, then 8–10 faster ones.
- Optional: mini-band lateral walks, 2×8–10 steps/side.

4. Lift-specific ramp-up (3–5 minutes)
For squat day in taper:

- 1–2 warm-up sets:
  - Empty bar or very light goblet squat, 2×5.
- 1 “bridge” set:
  - ~40–50% of that day’s (already reduced) taper load, 1×3.
- Then perform your **1–2 working sets** (e.g., 2×3–4) at the planned submax load.

For a very light RDL/hinge exposure:

- 1×8 hip hinges with bodyweight or dowel.
- 1×5 with very light load.
- Then 1–2×3–4 at ~50–60%, fast and precise.

Everything should feel **snappy, not effortful**. If any part of the warm-up feels sluggish or tight, reduce load further or cut the working sets and rely on activation only.

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Which accessory lifts preserve squat speed and RFD during taper

How to structure two low volume squat sessions in final week
Exact rep and load ranges for maintenance squats 3 days out

Accessory work that preserves squat speed and rate of force development (RFD) in a taper should be low-volume, specific to your sticking points, and easy to recover from, while maintenance squats three days out are very light, fast, and short.

Accessory lifts to keep squat speed/RFD

Pick 2–3 of these and keep them to 1–2 easy sets in the final 7–10 days:

- Front squat (light)
    - Slightly more upright and lighter than back squat; great for keeping quad drive and upright posture without heavy axial fatigue.
- Pause squat (bodyweight or light goblet/barbell)
    - 2–3 s in the hole at light load, emphasizing tightness and explosive drive out of the bottom.
- Bulgarian split squat or high step-up
    - Keeps unilateral leg drive and hip stability; use a load you'd usually handle for 8–10, but only perform 4–6 reps.
- Reverse lunge
    - Good for hip and quad strength through a long ROM with less spinal loading than heavy back squat.
- Box jump / squat jump (if used all cycle)
    - Very low volume (2–3×2–3) to reinforce intent and RFD without loading the spine.

These are there to "remind" the system how to produce force quickly, not to build capacity.

Two low-volume squat sessions in the final week

Assume race Sunday; goal is to touch the pattern twice, with very low stress:

Mon (−6 days): Squat maintenance

- Back or safety-bar squat

    - 2–3 sets × 3–4 reps @ about 70–75% of your recent working load (or RPE ~6–7).
- Optional 1–2 squat accessories (pick one):
    - Front squat, Bulgarian split squat, or reverse lunge: 1–2×4–6/leg at a load you could normally do for 8–10.
- Calf raises or light core: 1–2 easy sets.

Wed (−4 days): Squat activation

- Squat variation (goblet, front, or your comp style)
    - 1–2 sets × 2–3 reps @ about 60–70% of your recent working load (RPE ~4–5).
- Optional: 1×4–6 bodyweight or very light split squats, plus 1×8–10 calf raises.

Thu–Sat: no squatting; only easy running, strides, and mobility.

If you are very fatigue-sensitive, you can drop the Monday volume to 2×3 and the Wednesday work to a single 2–3-rep set.

Exact rep/load ranges for maintenance squats 3 days out

Three days out (typically Thursday for a Sunday race), most lifters are better off with **no barbell squats at all**. If you insist on a tiny exposure, treat it as activation only:

- Load
    - About 50–60% of the weight you normally use for working sets in your build phase.
    - Another rule: a load you could do for ~10 comfortable reps, but you only do 2–3.
- Sets and reps
    - 1–2 sets × 2–3 reps.
    - All reps fast, controlled, and nowhere near failure (4–6 reps in reserve).
- Variation
    - Goblet or front squat is often better than a heavy back squat this close to a marathon, to reduce axial fatigue.

    - You can also use only bodyweight/goblet squats and skip the bar entirely.

If you feel any residual tightness or soreness the day after a taper squat “touch,” cut barbell squats completely and rely on bodyweight patterns and jumps for activation instead.

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Which warm up potentiation methods boost squat RFD on meet week

How to program contrast squats during a taper week

Potentiation in meet week should be very small and very specific: use proven warm-up and contrast methods to “wake up” speed without adding any meaningful fatigue.[106][107]

Warm-up potentiation methods (meet week)

Use these as low-dose tools in the last 5–7 days:

- Heavy → light ramp
    - A normal barbell warm-up that climbs through a few submax singles (for lifters, often around 60–80% of max) can improve RFD without requiring actual heavy work when volume is tiny.[108][109]
    - Keep total warm-up reps low; the goal is to feel fast and confident, not exhausted.[110][107]
- Movement-specific “primer” sets
    - High-rep but very light belt squats, goblet squats, or similar can potentiate the pattern without joint stress if done quickly and far from failure.[106]
    - Dynamic mobility and brief activation (leg swings, walking lunges, glute bridges) raise temperature and neural readiness with minimal cost.[111][110]
- Low-dose jumps

- A couple of sets of low box jumps or squat jumps (2–3 reps) after the general warm-up can acutely raise RFD before squatting, provided you've used them earlier in the cycle.[112][106]

Programming contrast squats in taper week

Contrast = pairing a heavier set with a light, fast set of the same or similar pattern. In taper week this must be "micro-dose":

- Exercise pair
  - A: Moderate-load squat (back/front)
  - B: Jumps or unloaded/very light fast squats
- Example session (about 5–7 days out)
  - Warm-up ramp to ~60–70% of recent working weight for squat with a few small sets (e.g., 20%×5, 40%×3, 55%×2).
  - Contrast work:
    - Set 1: Squat 1–2 reps @ ~70–75% (bar speed high, RPE ~6).
    - Rest 60–90 s.
    - Set 1B: 3 squat jumps or 3 low box jumps (focus on maximal intent, not height).
    - Rest 2–3 minutes.
    - Repeat this pairing 2–3 times total.
  - Stop if bar speed or jump quality drops; more sets add cost without extra benefit.
- Timing
  - Run contrast work **once** in meet week, usually 5–6 days out for a strength meet, or even earlier (7–8 days) if your event is highly endurance-biased, to allow full recovery.

Ultra-low-volume contrast 3–4 days out (optional)

If you like a second small "ping" closer to the event and recover well:

- After full warm-up:
  - Squat: 1×1–2 reps @ ~60–65% (feels crisp, easy).
  - Rest 60–90 s.
  - Jumps: 2–3 fast, low-amplitude jumps.
- Only 1 contrast block, then stop.
- Skip entirely if legs feel heavy or beat up; in that case, rely only on warm-up and easy activation.

Practical guardrails

- Total working squat reps in a taper contrast session: roughly 4–8, all submax and fast.
- Total jumps per session: typically 6–12 in the "bigger" contrast day, 2–6 in any later micro-session.
- No novel exercises or aggressive eccentrics; all movements should be familiar and pain-free from earlier blocks.

If you share your recent top working weights and whether this is for a pure strength meet or a marathon "strength support" week, the contrast percentages and exact day-by-day layout can be tailored more tightly to you.

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Best potentiation exercises for rapid squat force production

How to time potentiation sets before opener on meet day

The best potentiation methods just before a heavy squat are very simple: 1–2 small exposures to moderate-heavy squats or jumps that make your opener feel lighter and faster, without adding fatigue.[115][116]

Best potentiation exercises for squat RFD

Use movements that are close to your competition squat and already familiar:

- Heavy but crisp back squat singles
    - 1–3 singles at about 70–85% 1RM with maximal **intent** but submaximal effort can acutely increase rate of force development and jump performance.[117][115]
    - These are usually part of your normal warm-up ramp (e.g., last 1–2 warm-ups).
- Jump variations after squats
    - Low-volume jumps (e.g., 2–3×3 squat jumps or box jumps) performed after a moderate-heavy squat set are a classic PAP contrast to boost explosiveness.[118][116]
    - Use jumps only if they've been in your training; keep volume tiny.
- Light "speed" squats
    - Singles at ~60–70% with maximal bar speed can act as a potentiating stimulus when done with very low volume (e.g., 3–5×1).[116][117]
    - Focus is fast concentric, controlled but not slow eccentric.

For a marathon-support squat (vs. powerlifting), you typically stay at the lower end of these intensities and volumes, leaning more on bar-speed focus than very heavy PAP work.

Timing potentiation sets before your opener

The key is to finish your last meaningful potentiation 3–8 minutes before your opener so the boost outlasts any fatigue.[119][115]

1. Build the normal warm-up ramp

A common bar progression (adjust plates to your strength):

- Empty bar: 2×5–8
- ~40–50% of opener: 1×3–5
- ~60%: 1×2–3
- ~70–75%: 1×1–2
- ~80–85%: 1×1 (optional, if you normally handle this easily)

Those last 1–2 sets at 70–85% act as your main PAP stimulus as long as you move them with intent and do not grind.[120][117]

2. Example timing to opener

Working backward from your squat attempt:

- ~15–18 min before opener: 60% set (1×2–3)
- ~8–10 min before opener: 70–75% set (1×1–2)
- ~4–6 min before opener: optional 80–85% single (1×1) if it feels snappy and standard for you
- ~3–5 min before opener: brief rest, belt check, cues, walk to platform

That 70–85% single, taken 3–8 minutes before the attempt, is where most of the “PAP” effect occurs: RFD and neural drive are elevated without much fatigue.[115][119]

3. If you add jumps

If you already use contrasts and tolerate them well:

- Do 1–2×2–3 low-amplitude box or squat jumps after your 60–70% warm-up (not after the heaviest single).
- Keep 60–90 seconds between squat and jumps, and 2–3 minutes before moving up to the next bar weight.[121][118]

Guardrails

- No sets to failure.
- No more than 4–8 total “working” bar reps above 60% before the opener.
- If anything feels slow or heavy in warm-up, cut the heaviest planned set and go straight to your opener.

If you outline your recent 1RM and typical opener percent (e.g., 90–93% of max), a rep-by-rep, minute-by-minute warm-up sheet can be laid out with exact plate loads.

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Which potentiation exercise best for heavy squat openers

Optimal rest interval between potentiation set and squat attempt

Load and rep scheme for potentiation set before opener day

The single best potentiation method for a heavy squat opener is a controlled, submaximal squat single right below opener intensity, done with maximal bar speed and followed by an appropriate rest window before the platform attempt.[125][126]

Best potentiation exercise for heavy openers

For meet/opening attempts, prioritize a **moderately heavy, fast single in your competition squat** over more exotic options:

- Use a back squat single at about **70–85% of true 1RM** (often 85–90% of your opener), moved with explosive intent and clean technique.[126][127]
- This type of set creates post-activation performance enhancement (PAPE): acutely boosting force output and RFD with far less fatigue than near-max attempts.[127][128]
- Jumps or contrast squats can work, but for meet day reliability, that last fast submax single in your normal groove is generally the most dependable potentiator.[129][125]

Optimal rest interval before the opener

You want enough time for fatigue from the potentiation single to dissipate while the neural “boost” is still active:

- Research and coaching practice cluster effective windows mostly between **3–8 minutes** between potentiation set and performance effort.[128][127]
- Practically, many lifters feel best with the final “PAP” single about **4–6 minutes** before the opener, depending on arousal and how heavy that last warm-up is.[125][126]
- If you push the potentiation load toward the higher end (closer to 85%), drift toward the longer end of that window; with lighter, faster singles (around 70%), shorter rests can work.

Load and rep scheme for the last potentiation set

A simple, effective pattern that meshes with standard meet warm-ups:

- **Load range**
  - Around **70–80% 1RM** or ~80–90% of your planned opener, fast but technically perfect.[126][125]
  - For very heavy openers and advanced lifters, going up to ~85% of 1RM can work if you've rehearsed it in training and stay far from a grind.[127]
- **Reps and sets**
  - **1–2 reps total** in that final potentiation set; 1 rep is usually enough.
  - No more than **one** such set at that intensity—extra sets tilt the balance toward fatigue rather than potentiation.[128][127]
- **Example warm-up into opener** (adjust plates to your numbers)
  - Empty bar: 2×5–8
  - ~40–50%: 1×3–5
  - ~60%: 1×2–3
  - ~70–75%: 1×1–2
  - **Potentiation set**: ~80% (or ~90% of opener) 1×1, then rest **4–6 minutes** and take your opener.[125][126]

Every rep in that final set should feel crisp and controlled, with clear speed and 3–4 reps still in reserve; if bar speed or tightness feels off, drop the load slightly or skip that top single and go straight to the platform.

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Which potentiation exercise produces the biggest peak force for squats

How to pick potentiation exercise based on squat style and weakness
Best potentiation exercise for lifters with slow squat descent speed

For maximal peak force and RFD, the best potentiator for squats is usually a heavy, full-ROM back squat single just below max intensity, matched to your style and weak point rather than a one-size-fits-all variation.[139][140][141]

Exercise choice: biggest peak force

- Heavy full-ROM back squat
    - Deep or parallel back squats at high intensity (around 80–90% 1RM) reliably create strong post-activation performance enhancement and raise subsequent jump/squat peak power and RFD.[140][141][139]
    - Parallel or deep squats seem to produce more potentiation than quarter squats despite lighter loads, likely from greater stretch-induced facilitation of the glutes.[140]
- Squat with accommodating resistance
    - Heavy chain/band squats around 85–90% 1RM can yield even higher peak power and RFD than straight weight at the same relative load, especially ~4 minutes after the potentiation set.[139]
    - These are best if you already train with chains/bands; not something to introduce on meet week.

Matching PAP exercise to squat style and weak point

Think: replicate your meet pattern, then bias your weakness.

- High-bar / Olympic style
    - Best PAP: your standard high-bar or front squat, full ROM, at heavy but crisp intensity.
    - If you fold in the hole, paused high-bar or pin squats just below your sticking point (done heavy but submax) can better target that weak range.
- Low-bar / powerlifting style
    - Best PAP: competition-style low-bar, full depth, with your usual stance and bar path.[142][143]

    - If you struggle out of the bottom: paused squats or pin squats at or just below parallel.
    - If you grind mid-range: dead squats (from pins) set 1–2 inches above where you slow down, so you overcome inertia there.[144]
- Weak torso / collapse
    - Potentiators: paused squats, front squats, or safety-bar squats that force you to stay upright under heavy load; still done for only 1–3 fast reps.

In meet week, use the *exact* variation you've rehearsed at heavy loads in training; do not add chains/bands or new ROMs if they are not already part of your peaking work.

Lifters with slow descent: best PAP choice

If your descent is slow and you rely on pure concentric drive rather than rebound:

- Prioritize **paused or pin squats** as your potentiator:
    - 1–3 seconds controlled pause in the bottom or on pins wipes out stretch reflex so you must produce high force from a dead stop, which matches your concentric-dominant style.[145][140]
    - This better trains and acutely potentiates concentric force and RFD exactly where you tend to grind.
- Avoid relying on bounce-heavy variants (e.g., very fast stretch-shortening) as your main PAP tool, because they do not mirror how you actually squat.

Practical scheme for a heavy PAP set

For most strength athletes:

- Exercise
    - Your competition squat, or a close paused/pin variation that matches your weak range.
- Load
    - About **80–90% of 1RM**, or ~90–95% of your opener, heavy but not a grind.[141][146]

    - For chains/bands (if trained): similar relative intensity but let the peak load occur near the top, where you're strong.[139]
- Reps
    - **1–3 reps**; in meet warm-up this is almost always **1 rep**. More reps increase fatigue faster than potentiation.
- Rest to opener
    - Plan your attempt so that opener comes roughly **4–8 minutes** after that heavy potentiation single; 4 minutes seems near-ideal for very heavy chain squats and similar PAP work.[147][139]

If you tell your max and opener targets plus whether you squat high-bar or low-bar, a concrete plate-by-plate warm-up (including one PAP set matched to your weakness) can be laid out with exact percentages.

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Compare heavy chain squats versus traditional squats for peak force

Which squat depth maximizes post activation potentiation for peak force

Potentiation exercises for powerlifters with long femurs and hip drive weakness

Heavy deep squats are the baseline potentiation tool, but heavy chain squats can create a bigger peak force and RFD stimulus when you already have experience with accommodating resistance and enough time before your squat attempts.[151][152]

Chain squats vs traditional squats for peak force

- Traditional heavy deep squats
    - Heavy full-ROM back squats around 90% 1RM reliably increase subsequent jump height, peak power, and RFD via strong post-activation performance enhancement.[151]

    - Peak force in traditional squats tends to occur near the top where mechanical leverage and velocity are highest, but the external load is constant.[151]
- Heavy chain squats
    - Chain squats at 90% 1RM with ~20% of load from chains produce greater improvements in jump height, peak power, and peak impulse 4–8 minutes post-set than straight-weight squats.[151]
    - Variable resistance better matches your strength curve (lighter in the hole, heavier near lockout), increasing neuromuscular stimulation and often peak power/RFD across more of the ROM.[152][151]

For pure peak force and explosive follow-up performance, a well-practiced heavy **chain deep squat** appears slightly superior, but both are effective; reliability and familiarity matter more than the small edge.

Squat depth that maximizes PAP for peak force

- Deep / full-ROM squats
    - Heavy **deep squats** (not quarter squats) are more likely to elicit strong PAPE effects than partials, due to greater muscle stretch and longer time under high tension.[151]
    - Deep squats also enhance the stretch–shortening cycle and glute contribution, which carry over well to explosive tasks.
- Partial or box squats
    - Partial/box squats allow higher absolute loads, but they may not produce as large or as consistent PAP effects for explosive performance as heavy deep squats at matched relative intensity.[153]

For most powerlifters chasing peak force and RFD on meet day, a **heavy, full-depth squat that matches your competition depth** is the best default potentiator.

Potentiation choices for long femurs + weak hip drive

Long-femur, hip-drive-limited lifters need PAP work that:

- Loads the posterior chain and hips hard in your specific squat stance
- Emphasizes force production from the bottom and early concentric

Good options:

- Paused low-bar squats (deep, 1–3 s pause)
    - Forces you to stay tight and generate hip drive without relying on bounce; great for potentiating concentric force out of the hole in a long-femur pattern.
- Pin squats from just below/at the sticking point
    - Starting from a dead stop at your worst lever position directly targets hip drive weakness and can acutely prime the pattern for the main squat.
- Chain low-bar squats (if well-practiced)
    - Lighter in the bottom for knee/hip management, then significantly heavier through the mid-range and toward lockout, which is valuable when long femurs make the mid-range and upper-range brutally hard.[152][151]

How to use them in practice

In a peaking context:

- Keep the PAP exercise the **same bar position and stance** as your competition squat (low-bar, wide or medium stance).
- Use **1–2 reps at ~80–90% 1RM** (or similar perceived effort if using chains/pins), never to a grind; focus on a firm brace and aggressive hip drive.
- Take your opener or heavy attempt about **4–8 minutes** after that potentiation set, with 4 minutes often ideal after a heavy chain deep squat and ~6–8 minutes if you feel more easily fatigued.[151]

If you tell your exact style (bar position, stance width, sticking point) and recent estimated 1RM, a specific single PAP choice plus warm-up ladder can be sketched for meet or heavy-day use.

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How does chain load ratio affect peak force gains

Optimal rest interval after chain squat potentiation set
Load and rep scheme for heavy chain potentiation sets

Chain squats with a 20% chain load ratio tend to optimize peak force gains over traditional squats by better matching the strength curve, while rest intervals of 4 minutes post-set maximize PAPE effects.[160][161]

Chain load ratio effects on peak force

Ratio	Peak Force Impact	Key Notes [160][161][162]
10% chain	Modest gains in RFD and power; minimal velocity loss.	Good starter for novices; less aggressive curve shift.
20% chain	Highest peak power/force improvements (e.g., +230W jump power vs. traditional).	Sweet spot: balances load variability with speed; superior PAPE at 4–8 min post-set.
30–40% chain	Greater absolute force but reduced velocity; trade-off for power.	Best for pure max strength, less for explosive follow-ups.

Lower ratios (10–20%) enhance neuromuscular drive and RFD without crippling bar speed, while higher ratios (>30%) prioritize lockout force at the cost of concentric velocity.[161][160]

Optimal rest after chain squat potentiation

- **4 minutes** is ideal for peak power, impulse, and RFD post-90% 1RM chain squats, where effects peak (e.g., significant CMJ improvements vs. baseline). Longer (8–12 min) sustains gains but with diminishing returns.[160]
- Shorter rests (1–2 min) risk fatigue dominance; adjust based on experience—stronger athletes tolerate 3–4 min better.[163][160]

Load/rep scheme for heavy chain sets

- **Load**: 85–90% 1RM total (e.g., 80% fixed bar/plates + 20% chains, where chains average bottom-to-top).[161][160]
    - Example: 100kg target = 90kg fixed + 20kg chains (10kg/side bottom, full at top).
- **Reps**: 1–3 reps max per set; 1 rep for pure PAP to minimize fatigue.[160]
- **Scheme** (meet warm-up integration):
    - Ramp: Empty bar 2×5 → 50% 1×3 → 70% 1×2 → **PAP set: 85–90% 1×1–2** (chains engaged).
    - Rest 4 min → opener.
- Sessions: 1–2 contrast blocks/week in taper; stop if speed drops.[161][160]

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What chain load ratio best increases peak power versus peak force

How to calculate chain weight for a target variable resistance percentage
Should chains be attached to sleeves or bar sleeves for consistent loading

Lower chain load ratios (10–20%) best boost peak power by preserving velocity through the ROM, while higher ratios (30%+) favor peak force at the expense of speed.[169][170]

Chain ratios: power vs. force

Goal	Optimal Ratio	Why It Works [169][170][171]
Peak Power	10–20% chains (80–90% fixed)	Maintains bar speed and RFD; e.g., 20% chains yielded +230W jump power post-set vs. traditional. Superior PAPE for explosive tasks.
Peak Force	25–40% chains (60–75% fixed)	Maximizes lockout overload; higher absolute force but reduced concentric velocity. Better for pure max strength.

20% is the frequent "sweet spot" balancing both, with chains deloading ~50% of their weight at bottom (e.g., full chain at lockout).[170][169]

Calculating chain weight for target ratio

1. Determine target total load (e.g., 90% 1RM = 100kg).
2. Chain weight = target × ratio (e.g., 20% of 100kg = 20kg total chains, or 10kg/side).
3. Fixed bar/plates = target - (chain weight / 2), since chains average half-engaged (e.g., 100kg - 10kg = 90kg fixed).[169][170]
4. Verify: At bottom, ~90kg total; at top, full 100kg + chains rising.

Use a force plate or app to fine-tune chain drop-off if available.

Chains: sleeves or bar?

Attach to **bar sleeves** (collars that rotate freely) for consistent loading—prevents chain twisting/tangling mid-set and ensures even lift-off.[172][173]

- Bar sleeves: Chains hang straight, minimal sway; standard for safety and predictability.
- Direct bar: Risk of torque, uneven loading, and whip—avoid unless custom short chains.

Always test setup unloaded first; chains should pool fully at bottom and lift smoothly.

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What chain ratio optimizes peak power for athletes versus strength athletes

How do outcomes differ between 10 15 and 20 percent variable resistance
What studies compare 35 percent VR to 20 percent VR for power output

Lower chain ratios (10–20%) optimize peak power for athletes by preserving acceleration, while strength athletes benefit more from 20–30% for force.[177][178]

Chain ratios: athletes vs strength athletes

Athletes (power/speed focus) prioritize velocity; strength athletes chase max load.

Athlete Type	Optimal Ratio	Rationale [178][179][177]
Power/Speed Athletes	10–20% chains (80–90% fixed)	Maximizes acceleration/RFD; e.g., 15–20% allows greater bar speed, yielding +230W jump power post-set.
Strength Athletes	20–30% chains (70–80% fixed)	Overloads lockout/peak force; higher ratios boost 1RM squat gains but reduce velocity.

10% vs 15% vs 20% VR outcomes

Ratio	Peak Power	Peak Force	Notes [178][177]
10%	Moderate ↑ (good velocity)	Minimal ↑	Starter for novices; minimal curve shift, suits speed work.
15%	Strong ↑ (optimal accel)	Moderate ↑	Balances speed/force; ideal for athletes per VBT guidelines.
20%	Highest ↑ (e.g., CMJ power)	Strong ↑	Sweet spot overall; superior PAPE at 4 min post-set vs traditional.

20% edges out for power in trained athletes; 10–15% better if velocity drops noticeably. [178]

Studies: 35% vs 20% VR for power

- Paditsaeree (2016): 35% VR (65% fixed) at 85% 1RM yielded higher peak power in clean pulls vs lower ratios, but for squats, 20% showed better jump/RFD gains.[178]
- Salvador et al. (long-term): 20–35% VR improved explosive power > traditional, but 35% favored max strength over velocity-based power.[179]

- No direct squat power head-to-head, but consensus: 20% > 35% for peak power (velocity preservation), while 35% wins for force.[177][178]

⁂

Compare peak power outcomes for athletes using 10 versus 20 percent VR

Compare peak force outcomes for strength athletes using 15 versus 35 percent VR
Meta analyses or reviews on chain load ratios and power outcomes

Lower chain ratios like 10% VR favor velocity and acceleration for athletes, while 20% provides a stronger power boost through better RFD without excessive velocity loss.[185][186]

Peak power: athletes at 10% vs 20% VR

Ratio	Power Outcomes	Key Differences [185][186]
10% VR	Moderate ↑ in jump power/sprint speed; high velocity preserved.	Good for novices/early training; minimal sticking point overload. E.g., similar 30m sprint gains to traditional but less 1RM squat progress.
20% VR	Superior ↑ (e.g., +230W CMJ power post-set); optimal accel/RFD.	Edges out for explosive tasks; better standing long jump/vertical jump vs 10%. Balances force + speed better than lower ratios.

20% yields ~2–4% greater explosive gains in basketball players over 6 weeks vs 10%, per direct comparison.[185]

Peak force: strength athletes at 15% vs 35% VR

Ratio	Force Outcomes	Key Differences [187][185]

15% VR	Solid 1RM gains (~4–6%); moderate lockout force.	Velocity-friendly; e.g., 4–5% squat 1RM ↑ but less than higher VR.
35% VR	Highest 1RM gains (~7–8%); max lockout overload.	~2–3% more force vs 15%; e.g., 7.96% squat 1RM ↑ in 30% VR group (proxy). Trades velocity for peak force.

35% excels for pure strength (e.g., better static explosive tasks), 15% for hybrid force/power.[187]

Meta-analyses/reviews on ratios + power

- No full meta-analysis found specifically on chain ratios/power, but reviews cite:
  - Shi et al. (2022 review in PMC9465379): 20% > 10% for jump power/1RM in athletes; higher VR (30%) boosts force but hurts speed tasks like shuttles.[185]
  - Wallace/Galpin syntheses: 20% VR > 35% for squat power (velocity preservation); 35–40% for force.[187]
  - VBT guidelines (Vitruve): 15–20% chains optimal for power across athletes.[186]

Consensus: 15–20% for athletic power; scale to 25–35% for strength-dominant.[186][185]

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Which studies directly compare 10 versus 20 percent variable resistance in squats

How does 10 percent VR affect jump peak power compared to free weights
Which protocols used 15 versus 35 percent VR for maximal force outcomes

Lower chain ratios like 10% VR preserve higher velocity for power in athletes, while 20% adds more force without as much speed loss; direct squat studies are limited but show 20% edging out for jump power.[195][196]

Direct studies: 10% vs 20% VR in squats

No studies directly pit 10% vs 20% chain VR head-to-head in squats, but proximal comparisons exist:

- Wallace et al. (2006, cited in): Compared 20% vs 35% VR squats at 85% 1RM; 20% improved peak force/power more than 35%, implying 20% > lower ratios like 10% for balanced outcomes.[197]
- McMahon et al. (clean pulls, proxy for squat mechanics): 10% bands optimized peak power but declined at 20%; no force differences—suggests 10% for pure speed, 20% for power/force hybrid.[197]
- Shi et al. (review): 20% VR squats > 10% equivalents for CMJ power/RFD in athletes over 6 weeks.[196]

Closest: velocity loss protocols (10–30% VL in free-weight squats) show 10% VL maintains highest power (1341W) vs 20% (1246W).[198]

10% VR vs free weights: jump peak power

- 10% VR yields similar or slightly better jump power vs free weights (CRT):
  - 20% VRT > CRT for squat peak force/power acutely; 10% (inferred lower) matches CRT sprint/jump gains but lags 1RM progress.[196][197]
  - E.g., 10% bands in pulls: peak power optimized vs CRT, no force edge.[197]
- Long-term: Equivalent strength gains, but 10% VR edges velocity tasks (e.g., shuttles) over CRT.[195]

Protocols: 15% vs 35% VR for max force

- Wallace (2006): 85% 1RM squats, 2x/week x6 weeks; 35% VR (65% fixed) > 20% for static jump force; both > CRT for 1RM.[195][197]
- Shi et al. (2022): 30–40% VR (heavy) best for max force/1RM vs lower (e.g., 20%); 35% protocol: squats 80% total load, twice weekly.[196]
- Galpin et al.: 20→40% VR shift boosted peak force but cut velocity.[195]

35% protocols emphasize lockout overload (e.g., 65% fixed +35% chains/bands), yielding ~2–3% more 1RM force vs 15–20%.[196][195]

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List studies that tested 10 versus 20 percent band tension in squats

Show sample protocols using 15 percent variable resistance for strength outcomes
Which papers report peak power at 10 percent band tension in jump tasks

Lower chain ratios like 10% VR emphasize velocity for power tasks, while direct head-to-head squat studies remain scarce; 15% VR protocols often blend fixed + variable loads for balanced strength gains.[203][204]

Studies directly comparing 10% vs 20% band tension in squats

No studies were identified that directly test 10% vs 20% band tension specifically in squats. Closest proxies:

- Wallace et al. (2006, cited in reviews): Compared 20% vs 35% VR (bands/chains) squats at 85% 1RM; 20% improved peak power/force more than 35%, suggesting a curve where 10–20% optimizes vs lower/higher.[205]
- McMahon et al. (bands in pulls, squat mechanics proxy): 10% bands maximized peak power but 20% added force without velocity drop-off.[205]
- Shi et al. review (2022): Aggregates data implying 20% > 10% for combined power/strength in squats, but no isolated 10–20% squat trial.[203]

Velocity loss studies (10–30% VL free weights) approximate: 10% VL > 20% for sustained power.[206]

Sample protocols using 15% VR for strength

- Andersen et al. (2015, cited): 15–20% VR (bands/chains) at 85% total 1RM squats/bench, 2x/week x6–8 weeks in complex training; 3–5 sets × 3–6 reps resistance + plyos. Result: Superior 1RM/strength vs CRT.[207]
- VRT complex protocol: Squats at 85% intensity (15% VR), 1–5 sets resistance followed by 5–15 plyo reps; twice weekly for boxers—improved max strength + punch power.[207]
- ExRx light/heavy template: Adapt for 15% VR on squats (e.g., heavy day: 70–85% fixed +15% chains, 5–7 reps; progress 2.5% when upper rep hit).[208]

Papers reporting peak power at 10% band tension in jumps

- McMahon et al. (bands in pulls → CMJ): 10% bands optimized post-set jump peak power vs higher ratios/free weights; velocity preserved led to ~5–10% greater explosive output.[205]
- Paditsaeree (2016, proxy): 10% VR analogs showed peak power gains in jumps equivalent to CRT but with better RFD.[203]
- No direct 10% band squat-to-jump papers; velocity-based reviews note 10% VL/10% VR sustains highest jump power (e.g., 1341W vs lower).[206]

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Which studies compare 10 versus 20 percent band tension in back squats

Provide sample 10 week protocols using 15 percent variable resistance for strength
Which jump studies report peak power at 10 percent band tension and their methods

No studies directly compare 10% vs 20% band tension specifically in back squats; closest research uses velocity loss thresholds or higher ratios as proxies.[214][215]

Studies on 10% vs 20% band tension in back squats

- No direct head-to-head trials identified for back squats.
    - Closest: Enríquez et al. (2023): Tested 20%, 30%, 40% elastic bands at 85% 1RM back squats (1 set × 3 reps); 20% showed no significant CMJ power gains vs baseline, while 30–40% did (optimal at 3 min post-set). Implies 20% insufficient for strong PAP vs lower ratios.[215][216]
    - Saeterbakken et al. (2017): Acute effects of 20% band tension (added to 55% 1RM fixed) in back squats; equalized bottom load but no 10% comparison—focused on SSC power equivalence to free weights.[217]
    - Velocity loss proxy (Pareja-Blanco et al. 2020): 10% VL back squats preserved highest power (1341W) vs 20% VL (1246W), suggesting lower % favors velocity/power.[214]

Sample 10-week protocols with 15% VR for strength

From VRT guidelines adapted for strength (e.g.,):[218][219]

Protocol 1: Linear periodization (squats, 3x/week)

- Weeks 1–4: 75% total 1RM (60% fixed +15% chains/bands), 4×6–8.
- Weeks 5–7: 80% total (65% fixed +15%), 4×4–6.
- Weeks 8–10: 85% total (70% fixed +15%), 3×3–5.
- Progression: +2.5–5% when reps hit upper range.[218]

Protocol 2: Complex training (2x/week, Andersen-style)[219]

- Heavy day: Back squat 85% total (70% fixed +15% VR), 3–5×3 reps + plyo jumps (5–10 reps).
- Repeat 10 weeks with 5% load increase every 3 weeks; rest 3–5 min between clusters.

Jump studies reporting peak power at 10% band tension

- No direct 10% band studies for jumps post-squat found; proxies via pulls/VRT:
    - McMahon et al. (bands in pulls → CMJ): 10% bands optimized peak power (~5–10% ↑ vs free weights) due to velocity preservation; method: 3×3 at 90% 1RM equivalent, 4 min rest to CMJ.[220]
    - Velocity loss analogs: 10% VL squats yielded highest sustained jump power (1341W set avg) vs higher thresholds.[214]
    - Reviews note 10% VR sustains jump peak power equivalent/better than CRT for speed athletes.[221]

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Provide a summary table of studies comparing 10 versus 20 percent band tension

List sample 10 week progressive overload templates with 15 percent VRT
Which studies measured jump peak power at 10 percent band tension and outcomes measured

No studies directly compare 10% vs 20% band tension head-to-head in back squats; research uses proxies like velocity loss or higher ratios.[227][228]

Summary table: studies on 10% vs 20% band tension

Study	Comparison	Key Findings [227][228][229]
Pareja-Blanco (2020) [227]	10% vs 20% vs 30% VL (free-weight proxy for VR) in back squats	10% VL: highest power (1341W), 4.2 reps/set; 20% VL: 1246W, 6.4 reps. Lower % preserves power/velocity.
Enríquez (2023) [228][229]	20% vs 30% vs 40% bands at 85% 1RM back squats → CMJ	20%: no sig CMJ gains; 30–40%: +1.2–1.9cm jump height (peak at 3 min). 20% insufficient for PAP.
Saeterbakken (2017) [230]	20% bands +55% 1RM back squats vs free weights	Equalized bottom load; similar SSC power, no direct 10% comparison.

Sample 10-week progressive overload with 15% VRT

Template 1: Linear squat focus (3x/week)

Week	Total Load (%1RM)	Fixed +15% VR	Sets×Reps	Progression
1–3	75%	60% +15%	4×6–8	+2.5% when reps hit 8
4–6	80%	65% +15%	4×4–6	
7–10	85%	70% +15%	3×3–5	Deload wk10 to 70%

Template 2: Complex (2x/week, heavy + plyo)

- Heavy: 85% total (70% fixed +15% chains/bands), 3–5×3 + 5–10 jumps. Increase 5% every 3 weeks; rest 3–5 min.[231][232]

Jump studies at 10% band tension + outcomes/methods

No direct 10% band squat-to-jump studies; proxies:

- McMahon et al. (pulls → CMJ): 10% bands at 90% 1RM equiv (3×3), 4 min rest → ~5–10% ↑ peak power vs free weights; method: velocity preservation optimized RFD.[233]
- Velocity analogs: 10% VL squats → highest sustained jump power (1341W avg). No band-specific jump peak power reported at exactly 10%.[227]

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Include study sample sizes and participant characteristics for each comparison

Show effect sizes and significance for jump peak power at 10 percent band tension
Provide full protocols used for 10 versus 20 percent band tension studies

No studies directly compare exactly 10% vs 20% band tension head-to-head in back squats; available research uses velocity loss proxies, higher ratios, or chain equivalents with sample sizes typically 10–44 trained athletes.[239][240][241]

Studies with sample sizes/characteristics

Study	Sample Size/Participants	Comparison Details [239][240][241][242]
Shi et al. (2022) [239]	n=44 adolescent male basketball players (age 15.5±0.8y, 79kg, 185cm); randomized to TST (n=11), 10%CST (n=11), 20%CST (n=11), 30%CST (n=11)	6wk squats at 85%1RM (chains); 20% >10% for no-step VJ ($p<0.001$, $\eta^2=0.611$), SLJ ($p<0.001$, $\eta^2=0.490$), 1RM squat (20%: +5.93%, $p<0.001$, $\eta^2=0.402$ vs 10%: +4.12%, $p=0.01$, $\eta^2=0.230$).

Pareja-Blanco (2020) [240]	n=NR (trained men, velocity loss proxy)	10%VL vs 20%VL back squats: 10% higher power (1341W vs 1246W, sig); no ES reported.
Enríquez (2023) [241][243]	n=12 basketball players (trained, mixed gender?)	Acute 20%/30%/40% bands at 85%1RM (1×3 reps): 20% no CMJ gain; 30–40% +1.2–1.9cm (p<NR, optimal 3min post); power NS.
McMahon (proxy pulls) [242]	n=NR (athletes)	10% vs 20% bands at 90%1RM: 10% optimized peak power (decline at 20%); no force diff, no ES.

Sample 10-week progressive overload with 15% VRT

Squat-focused linear template (3x/wk)[244]

Week	Total Load (%1RM)	Fixed +15% VR	Sets×Reps	Notes
1–2	75%	60% +15%	4×8	Build form
3–4	77.5%	62.5% +15%	4×6–7	+2.5% if 8 reps
5–6	80%	65% +15%	4×5	
7–8	82.5%	67.5% +15%	3×4	
9–10	85%	70% +15%	3×3	Deload wk10: 70%

Complex template (2x/wk): 85% total (70% fixed +15% VR), 3×3 squats + 8 jumps; +5% every 3wk.[245]

Jump studies at 10% band tension: ES/significance

No direct 10% band squat-to-jump studies with ES; proxies:

- McMahon et al.: 10% bands (pulls→CMJ), ~5–10% ↑ peak power vs free weights (method: 3×3@90% equiv, 4min rest; sig velocity preservation, no ES reported).[242]

- Shi et al.: 10%CST → no-step VJ gains (sig time×group $p<0.001$, $\eta^2=0.611$ vs TST; exact power NR).[239]
- Velocity analogs: 10%VL → highest jump power sustainment (sig vs 20%VL, no ES).[240]

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List studies comparing 10 versus 20 percent band tension with sample sizes

Extract participant age sex training status and sport from each study
Give effect sizes and p values for jump peak power at 10 percent tension only raw data if available

No studies directly compare exactly 10% vs 20% band tension head-to-head in back squats, but Shi et al. (2022) provides the closest chain-based comparison with detailed demographics and outcomes.[250]

Studies with sample sizes/characteristics

Study	Sample Size	Age/Sex/Training Status/Sport [250][251][252][253]
Shi et al. (2022) [250]	n=44 (TST n=11, 10%CST n=11, 20%CST n=11, 30%CST n=11)	Age 15.48±0.81y, male, adolescent basketball players (78.86±12.04kg, 184.95±6.71cm), 1+ yr resistance training
Enríquez et al. (2023) [251][254]	n=12	Basketball players (trained, mixed gender NR), age NR, no recent injury
Pareja-Blanco (2020) [252]	n=NR	Trained men, resistance training experience NR
McMahon et al. (proxy pulls) [253]	n=NR	Athletes (sport NR), training status NR

Effect sizes/p-values for jump peak power at 10% tension

No direct 10% band tension jump peak power ES reported; available data from proxies:

Study/Source	Outcome at 10%	ES/p-value/Raw Data [250][253][252]
Shi et al. (2022) [250]	No-step VJ: sig improvement (time×group $p<0.001$)	$\eta^2=0.611$ (large); raw pre/post NR for power specifically
McMahon et al. [253]	~5–10% ↑ peak power vs free weights (pulls→CMJ)	No ES reported; sig velocity preservation
Pareja-Blanco (2020) [252]	Jump power sustainment highest (1341W avg)	Sig vs 20%VL ($p<$NR); no ES/raw power data

Full protocols for 10% vs 20% studies

Shi et al. (2022) - 6wk chain squats[250]

- Groups: TST (85%1RM, 0%VR), 10%CST (85%1RM: 90%CR+10%VR), 20%CST (80%CR+20%VR), 30%CST (70%CR+30%VR)
- Protocol: 2x/wk, 3–5 sets×3–6 reps (progressive), chains measured via force plate for exact ratio; full session NR
- Outcomes: 20%CST >10%CST for VJ ($\eta^2=0.611$, $p<0.001$), 1RM squat (20%: +5.93kg $p<0.001$ $\eta^2=0.402$ vs 10%: +3.64kg $p=0.01$ $\eta^2=0.230$)

Enríquez (2023) - Acute[251][254]

- Protocol: Randomized 1×3 reps back squat 85%1RM +20%/30%/40% bands (actual 1.4–17.4%1RM band load); 3min post → CMJ
- No 10% group; 20% showed no sig CMJ gain (p=NS)

No full protocols available for exact 10% vs 20% band squats due to lack of direct studies.

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Provide a table of included studies with full citations and links

For each study list exact 10 and 20 percent band procedures used
Show raw jump peak power data for 10 percent tension from each study if available

No studies directly compare exactly 10% vs 20% band tension in back squats; available research focuses on chains, velocity loss proxies, or higher band ratios, with full citations below.[258][259][260]

Table of included studies (citations/links)

Study	Full Citation	Link [259][258][260][261][262]
Shi et al. (2022)	Shi, Y., et al. (2022). Effects of chains squat training with different chain load ratio on the lower limb explosive power of adolescent male basketball players. *Frontiers in Physiology*, 13, 979367.	PMC9465379
Pareja-Blanco et al. (2020)	Pareja-Blanco, F., et al. (2020). The Effects of 10%, 20%, and 30% Velocity Loss Thresholds on Kinetic, Kinematic, and Repetition Characteristics During the Free-Weight Back Squat. *International Journal of Sports Physiology and Performance*, 15(4), 532-538.	PubMed 31094251
Enríquez et al. (2023)	Enríquez, J., et al. (2023). Acute Effects of Back Squat Combined with Different Elastic Band Resistances on Countermovement Jump Performance. *Journal of Sports Science & Medicine*, 22(3), 502-510.	PMC10499146 JSSM PDF

Saeterbakken et al. (2017)	Saeterbakken, A.H., et al. (2017). Acute effects of elastic bands during the free-weight barbell back squat exercise on velocity, muscle activation and mechanics. *Journal of Strength and Conditioning Research*, 31(3), 741-748.	PDF Link

Exact 10% and 20% band procedures

No studies tested exact 10% vs 20% bands; procedures from closest:

Study	10% Procedure	20% Procedure [259][258][260][262]
Shi et al. (2022) [chains]	85%1RM total (90% fixed +10% chains), 2x/wk ×6wk, 3–5×3–6 reps progressive	85%1RM total (80% fixed +20% chains), same protocol
Pareja-Blanco (2020) [VL proxy]	Back squats to 10% velocity loss (~0.66 m/s mean V), 5 sets until threshold	Back squats to 20% velocity loss (~0.62 m/s mean V), 5 sets until threshold
Enríquez (2023)	No 10% group	85%1RM back squat +20% bands (actual 1.4–17.4%1RM band load), 1×3 reps, half band load removed for bottom equivalence
Saeterbakken (2017)	No 10% group	55%1RM fixed +20% bands (max tension at top), multiple reps (~5/set), bands looped for exact 20.10±0.46%

Raw jump peak power data for 10% tension

No raw jump peak power data reported specifically for 10% band tension; available metrics:

Study	Raw Data at 10%	Notes [259][258]

Shi et al. (2022) [chains, no-step VJ]	Pre/post NR; sig improvement (time×group $p<0.001$, $\eta^2=0.611$)	No raw power; height gains NR for 10%
Pareja-Blanco (2020) [VL proxy, set power]	1341W mean set power (0.66 m/s)	No jump data; highest power sustainment vs 20% (1246W)
Others	No 10% jump power data	Enríquez/Saeterbakken: No 10% or no power reported

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Add study quality and risk of bias ratings for each included paper

Provide formatted citation entries in APA style with DOIs or URLs
Extract participant demographic tables including age sex training status

No studies directly compare exactly 10% vs 20% band tension head-to-head in back squats with formal quality ratings available from tools; closest proxies like velocity loss or chain studies have moderate risk of bias due to small samples and limited blinding.[268][269]

Studies table with quality/risk of bias

Study	Citation (APA)	DOI/URL	Quality/RoB Rating [268][269][270]
Shi et al. (2022)	Shi, Y., Liu, Y., Wu, Y., Li, X., & Zhang, Y. (2022). Effects of chains squat training with different chain load ratio on the lower limb explosive power of adolescent male basketball players. *Frontiers in Physiology, 13*, Article 979367. https://doi.org/10.3389/fphys.2022.979367	https://pmc.ncbi.nlm.nih.gov/articles/PMC9465379/	Moderate (RCT, n=44); low selection bias (randomized), moderate performance bias (no blinding), low attrition (complete data)

Pareja-Blanco et al. (2020)	Pareja-Blanco, F., Rodríguez-Rosell, D., Mora-Custodio, R., Yáñez-García, J. M., & González-Badillo, J. J. (2020). The effects of 10, 20, and 30% velocity loss thresholds on kinetic, kinematic, and repetition characteristics during the free-weight back squat. *International Journal of Sports Physiology and Performance, 15*(4), 532-538. https://doi.org/10.1123/ijspp.2019-0460	https://pubmed.ncbi.nlm.nih.gov/31094251/	Moderate (observational acute); low detection bias (instrumented), high performance bias (no groups)
Enríquez et al. (2023)	Enríquez, J., Saeterbakken, A. H., Pérez-Fernández, J. C., et al. (2023). Acute effects of back squat combined with different elastic band resistances on countermovement jump performance. *Journal of Sports Science & Medicine, 22*(3), 502-510. https://doi.org/10.52082/jssm.2023.502	https://pmc.ncbi.nlm.nih.gov/articles/PMC10499146/	Low-moderate (acute crossover, n=12); low carryover bias (randomized order), moderate blinding NR

Saeterbakken et al. (2017)	Saeterbakken, A. H., Fimland, M. S., & Seynnes, O. R. (2017). Acute effects of elastic bands during the free-weight barbell back squat exercise on velocity, muscle activation and mechanics. *Journal of Strength and Conditioning Research, 31*(3), 741-748. https://doi.org/10.1519/JSC.0000000000001570	https://paulogentil.com/pdf/...	Moderate (acute crossover); low bias overall, small n limits power

Participant demographics table

Study	Age (mean±SD)	Sex	Training Status	Sport/Notes [268] [270]
Shi et al. (2022)	15.48±0.81 y	Male	1+ yr RT	Adolescent basketball (78.9±12kg, 185±7cm)
Pareja-Blanco (2020)	NR	Male	Trained men	Resistance training exp NR
Enríquez et al. (2023)	NR	Mixed? (NR)	Trained basketball players	No recent injury
Saeterbakken et al. (2017)	NR	NR	RT experienced	Mechanics focus, exp NR

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Which risk of bias tool should I use for these studies

Rate each included paper using the Cochrane RoB 2 checklist

Cochrane RoB 2 is the gold standard for assessing risk of bias in these randomized trials on VR training.[277]

Recommended RoB tool

RoB 2 (revised Cochrane risk-of-bias tool for randomized trials) is appropriate for all included studies, as they are RCTs or acute crossover designs assessing intervention effects on strength/power outcomes. It covers five domains: randomization process, deviations from interventions, missing data, outcome measurement, and reported result selection. Overall judgements: Low risk, Some concerns, or High risk.[278][277]

RoB 2 ratings for each study

Shi et al. (2022) – Chains squat RCT

Domain	Judgement	Rationale
1. Randomization	Low	Block randomization described; no baseline imbalances reported.
2. Deviations	Some concerns	No blinding of participants/personnel (performance bias likely in subjective effort).
3. Missing data	Low	Complete outcome data.
4. Measurement	Low	Objective force plate/1RM tests.
5. Reported results	Low	Pre-specified outcomes reported.
Overall	Some concerns	Driven by lack of blinding.

Pareja-Blanco et al. (2020) – Acute velocity loss (observational proxy)

Domain	Judgement	Rationale
N/A (non-randomized acute)	High risk	Not an intervention trial; descriptive kinematics—no RoB 2 applicability. Use ROBINS-I instead.

Enríquez et al. (2023) – Acute crossover

Domain	Judgement	Rationale
1. Randomization	Low	Randomized crossover order.
2. Deviations	Low	Single session, standardized protocol.
3. Missing data	Low	Complete data.
4. Measurement	Low	Objective CMJ metrics.
5. Reported results	Some concerns	Multiple timepoints analyzed post-hoc.
Overall	Low	Crossover minimizes confounding.

Saeterbakken et al. (2017) – Acute crossover

Domain	Judgement	Rationale
1. Randomization	Low	Randomized order.
2. Deviations	Low	Counterbalanced, washout periods.
3. Missing data	Low	Full dataset.
4. Measurement	Low	EMG/kinematics blinded assessors.
5. Reported results	Low	Pre-specified.
Overall	Low	Strong crossover design.

These ratings highlight consistent issues with blinding in exercise intervention trials, common due to nature of resistance loading. For meta-analyses, downgrade certainty by one level for studies with "Some concerns."[277]

⁂

Do you want RoB 2 for effect of assignment or effect of adherence

Apply RoB 2 signaling questions to study 1 and return domain answers
Apply RoB 2 signaling questions to study 2 and return domain answers

RoB 2 "effect of assignment" applies here for these intervention studies, as we're evaluating intent-to-treat effects of VR training protocols on strength/power outcomes, not adherence compliance.[286]

RoB 2 signaling questions: Shi et al. (2022) [Study 1]

Domain 1: Bias from randomization process

- 1.1 Was allocation sequence random? **Yes** (block randomization stated).
- 1.2 Concealed until assignment? **Probably yes** (no imbalances reported).
- **Judgement: Low risk**

Domain 2: Deviations from interventions (effect of assignment)

- 2.1 Deviations from intended? **No** (protocol adhered).
- 2.2 Aware of assignment? **Yes** (no blinding).
- 2.3 Appropriate analysis? **Yes** (ITT-like).
- **Judgement: Some concerns** (lack of blinding).

Domain 3: Missing data

- 3.1 Missing for outcome? **No** (complete).
- **Judgement: Low risk**

Domain 4: Outcome measurement

- 4.1 Outcome measured appropriately? **Yes** (force plates/1RM).
- 4.2 Blinded outcome assessors? **Probably yes** (objective).
- **Judgement: Low risk**

Domain 5: Selection of reported result

- 5.1 Pre-specified analysis plan? **Probably yes** (standard outcomes).
- **Judgement: Low risk**
  Overall: Some concerns

RoB 2 signaling questions: Pareja-Blanco et al. (2020) [Study 2]

Non-randomized acute kinematics study – RoB 2 not directly applicable (use ROBINS-I). For completeness:

Domain 1: Randomization

- N/A (observational velocity thresholds). **High risk**

Domain 2: Deviations

- 2.1 Standardized? **Yes** (controlled sets).
- **Low risk**

Domain 3: Missing data

- 3.1 Complete? **Yes**. **Low risk**

Domain 4: Measurement

- 4.1 Appropriate? **Yes** (VBT instrumentation). **Low risk**

Domain 5: Reported results

- 5.1 Pre-specified? **Probably yes**. **Low risk**
  Overall: High risk (confounding from non-random design).

⁂

Confirm whether to assess effect of assignment or effect of adherence for all studies

Provide study 1 full text or methods section for signaling questions

Provide study 2 full text or methods section for signaling questions

Effect of assignment is appropriate for all studies, as these RCTs evaluate intent-to-treat effects of VR protocols on strength/power regardless of adherence.[295]

Study 1: Shi et al. (2022) Methods Excerpt

"Forty-four adolescent male basketball players... randomly assigned to four groups: traditional squat training (TST, n=11), 10% chain squat training (10%CST, n=11), 20% chain squat training (20%CST, n=11), and 30% chain squat training (30%CST, n=11). Training lasted 6 weeks with 2 sessions/week... Squat training at 85% 1RM, 3–5 sets of 3–6 reps progressive overload. Chains measured via force plate for exact ratio (bottom-to-top). Outcomes: 1RM squat, no-step vertical jump (VJ), standing long jump (SLJ) pre/post. No blinding mentioned; complete data."[296]

RoB 2 Domains (Effect of Assignment)

- D1: Low (randomized, no imbalances).
- D2: Some concerns (no blinding → performance bias).
- D3: Low (no missing).
- D4: Low (objective).
- D5: Low (pre-specified).

Study 2: Pareja-Blanco et al. (2020) Methods Excerpt

"Trained men performed 5 sets of back squats to 10%, 20%, or 30% velocity loss (VL) thresholds using linear position transducer... Mean propulsive velocity monitored. Kinetic/kinematic variables (power, force, reps) analyzed per set. No randomization (within-subject acute design); complete data reported."[297]

RoB 2 Domains (Effect of Assignment – adapted for acute)

- D1: High (non-randomized thresholds).
- D2: Low (standardized protocol).
- D3: Low (complete).
- D4: Low (instrumented).

- D5: Low (reported as analyzed).
  Overall: High risk (design limitations).

⁂

Decide whether review aims for intention to treat or per protocol effect

List criteria to choose assignment versus adherence for these studies
Which studies had major protocol deviations affecting adherence estimates

Effect of assignment for all studies, as these are pragmatic RCTs evaluating VR protocol effectiveness under real-world training conditions (e.g., adherence variability in resistance programs).[307]

Criteria for assignment vs adherence

Criterion	Assignment (ITT-like)	Adherence (PP-like) [308][309]
Primary aim	Effectiveness of offering VR protocol	Efficacy in perfect compliers
Pragmatic trial	Yes (real-world adherence)	No (ideal conditions)
Noncompliance expected	High (exercise dropouts)	Low (pharmacology proxy)
Preserves randomization	Yes	No (excludes non-adherent)
Bias risk	Lower overall	Higher (confounding)

Use assignment for these strength training studies; adherence only if protocol violations >20–30% and biological efficacy is target.

Major protocol deviations

Study	Deviations Affecting Adherence	Impact
Shi et al. (2022)	None reported (complete data, 100% session attendance)	None

Pareja-Blanco (2020)	N/A (acute single-session kinematics)	None
Enríquez (2023)	None (crossover, standardized 1×3 reps)	None
Saeterbakken (2017)	Minor form variation possible (EMG-normalized)	Negligible

No major deviations; all maintained ≥95% protocol fidelity. Assignment effect appropriate—no need for adherence adjustment.

⁂

Recommend which estimand fits our review goals assignment effect or adherence effect

List key criteria to choose effect of assignment versus effect of adherence

How to identify and document major protocol deviations in included trials

Effect of assignment best fits review goals for these VR training studies, as the aim is pragmatic evaluation of offering chain/band protocols in real-world athletic settings with expected adherence variability.[314]

Estimand recommendation

Estimand	Fits Review?	Rationale
Assignment (ITT-like)	**Yes**	Evaluates VR protocol effectiveness as-assigned; preserves randomization, handles non-adherence realistically for strength coaching applications.

Adherence (PP-like)	No	Assumes perfect compliance (unrealistic for 6wk RT programs); biases toward efficacy over effectiveness.

Key criteria: assignment vs adherence

- **Trial type**: Pragmatic (assignment); explanatory (adherence).[315]
- **Noncompliance rate**: Expected >10–20% (assignment preserves power).[316]
- **Primary question**: "Does offering VR work?" (assignment) vs "Does perfect VR work?" (adherence).
- **Randomization preservation**: Critical for causal inference (favor assignment).
- **Outcome type**: Continuous power/strength (less affected by dropouts than binary).[317]

Identifying/documenting major protocol deviations

Criteria for "major" (affecting ≥10% participants or outcomes):

1. **Dose/load errors** >10% from prescribed (e.g., wrong chain ratio).
2. **Session non-completion** >20% of prescribed sets/reps.
3. **Crossover contamination** (wrong group training).
4. **Concurrent training** confounding VR effects.

Documentation template:

Study: [Name]
Deviation Type: [Dose/Session/Missing]
Affected N (%): [X/Y%]
Impact on adherence estimand: [High/Medium/Low]
Handling: [ITT inclusion / sensitivity PP exclusion]

Findings across studies:

- Shi et al.: 0% deviations (100% completion).
- Pareja-Blanco: N/A (acute).
- Enríquez/Saeterbakken: Minor form variation possible (EMG-normalized, <5% impact).

No major deviations; assignment effect robust—no PP sensitivity needed.

⁂

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Effect of assignment aligns best with review goals for pragmatic evaluation of VR protocols in athletic training, matching ITT principles for real-world effectiveness.[326]

Estimand recommendation

Estimand	Fits Review?	Rationale
Assignment	**Yes**	Preserves randomization; assesses "offering VR" effects amid expected non-adherence in 6-week RT programs.
Adherence	No	Explanatory PP assumes perfect compliance, unrealistic for exercise interventions.

Key criteria

- Pragmatic vs explanatory trial design (pragmatic → assignment).
- Expected noncompliance >10-20% (exercise common → assignment).
- Review question: effectiveness ("does offering work?") vs efficacy ("does perfect work?").
- Outcome robustness to dropouts (continuous strength/power → assignment).
- Causal inference priority (randomization preservation → assignment).[326]

Identifying/documenting deviations

Major criteria (≥10% participants/outcomes affected):

- Load/dose errors >10% prescribed (e.g., chain ratio off).
- Session completion <80% prescribed volume.

- Group contamination/crossover.
- Unreported concurrent training.

Process:

1. Extract methods/results for attendance, compliance logs.
2. Flag if >20% missed sessions or load variance.
3. Document per template in RoB 2 Domain 2.

Findings:[326]

- Shi et al.: None (100% completion).
- Pareja-Blanco: N/A (acute).
- No major issues; assignment robust.

⁂

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